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ABSTRACT

The contribution to learning of the learning materials' arousal properties was investigated using degree of interest of the stimulus and response terms as the index of arousal. Words equated on meaningfulness, imagery, and concreteness and rated as high (H), medium (M), and low (L) in interest were used to represent the 3 levels of interest, and served as stimulus and response terms. Ninety students were randomly assigned to one of the 9 treatment conditions consisting of variations in interest on the stimulus and response side. The design called for 10 subjects per cell. The conditions were: H-H, H-M, H-L, M-H, M-M, M-L, and L-H, L-M, L-L. A planned comparison was performed on the response side. The data were also analyzed by trend analysis over 10 trials. The results revealed no significant difference between groups or within groups. The planned comparison suggested that the greatest amount of learning occurred in medium levels of response interest. However, high, medium, and low response effects were not significantly different from each other at conventional levels. The inverted U suggested in this study is in line with certain previous research. (Author)

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LEARNING AS A FUNCTION OF STIMULUS AND RESPONSE AROUSAL WITH CONTROL OVER MEANINGFULNESS, IMAGERY, AND CONCRETENESS

By Richard M. Mizelle and Frank H. Farley

Report from the Motivation and Individual Differences
in Learning and Retention Project

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The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement of related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This Technical Report is from the Motivation and Individual Differences in Learning and Retention Project from Program 1. General objectives of the Program are to generate new knowledge about concept learning and cognitive skills, to synthesize existing knowledge, and to develop educational materials suggested by the prior activities. Contributing to these Program objectives, the Learning and Memory Project has the long-term goal of developing a theory of individual differences and motivation. The intermediate objective is to generate new knowledge of the learning and memory processes, particularly their developmental relationship to individual differences and to motivation.

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ABSTRACT

The contribution to learning of the learning materials' arousal properties was investigated using degree of interest of the stimulus and response terms as the index of arousal. Words equated on meaningfulness, imagery, and concreteness and rated as high (H), medium (M), and low (L) in interest were used to represent the three levels of interest, and served as stimulus and response terms. Ninety students were randomly assigned to one of the nine treatment conditions consisting of variations in interest on the stimulus and response side. The design called for 10 subjects per cell. The conditions were: H-H, H-M, H-L, M-H, M-M, M-L, and L-H, L-M, L-L. A planned comparison was performed on the response side. The data were also analyzed by trend analysis over 10 trials.

The results revealed no significant difference between groups or within groups. The planned comparison suggested that the greatest amount of learning occurred in medium levels of response interest. However, high, medium, and low response effects were not significantly different from each other at conventional levels. The inverted U suggested in this study is in line with certain previous research.

INTRODUCTION

It is generally recognized that physiological and psychological factors are basic determinants of the acquisition rate and comprehension of learned material. The present learning study attempts to extend three areas of theory and research. The first area is related to the arousal-eliciting capacity of external stimulation. Berlyne (1960) was important in explicating the role of physiological arousal in a wide range of psychological phenomena. The second area follows Walker and Tarte's 1963 revision of the "action decrement" theory which is concerned with the effects of motivation on acquisition and retention using a consolidation theory of memory. One additional researcher has influenced this paper directly. Farley and his colleagues (Jones & Farley, 1970; Krueger & Farley, 1970) have undertaken a number of studies of the role of "interest" in learning. Jones and Farley (1970) studied the influence of "interestingness" on retention of random shapes and familiar words in a paired-associate (PA) task. The design of the present study manipulated the level of arousal (interest) produced by the stimulus and response terms in a PA task, but utilized a word-word paradigm. Recall measured over nine conditions was used to test the effects of degrees of arousal on learning.

In discussing the concept of arousal, one must refer also to certain elements of drive theory. Hull (1943) postulated that the strength (reaction potential) of any response that is aroused will increase with the total amount of drive that is present. The implication here is that drive and arousal are very closely related. Dell (1958) found that three prominent drive conditions—excess of carbon dioxide, hunger, and sexual receptivity—modified the chemistry of the blood in ways that sensitize the reticular formation and the responsiveness of the reticular formation to adrenaline and no adrenaline. It might be added, however, that arousal in this case is at the mercy of the organism's "physiological state" and does not include emotional or intellectual activities as possible arousal mechanisms. Another popular notion characterizes drive as a "condition whose termination or alleviation is rewarding" (Hull, 1943). This type of theory would encompass Skinner's "aversive condition" as well as Freud's "Trieb" or "instinct" theory of 1925. This theory implies generally that all learning depends on the action of rewards and that all rewards are instances of drive reduction (Dollard & Miller, 1950).

There is some question, however, as to whether the previously discussed theories of drive adequately cover the spectrum regarding the role of drive and arousal in learning. Sheffield, Wulff, and Backer (1951) found that incomplete sexual activity, interrupted while still in the phase of rising intensity, will reinforce a maze habit in the rat. Bruce (1938) found that a rat runs more speedily to a goal box that contains water if it drinks a few drops immediately before the trial, although the response is slowed down if it drinks appreciable quantities. Consequently, one must be cautious about drawing conclusions concerning the role of arousal. There is the possibility that arousal remains relatively low while a certain response is being performed, and rises as soon as the response ceases (Berlyne, 1960).

The importance of arousal as a motivator of behavior was outlined by Hebb (1955) and later refined by Duffy (1957), Berlyne (1960), and others. Hebb's theory was strongly influenced by the work of Moruzzi and Magoun (1949) who found that the reticular arousal system RAS located in the brain stem was responsible for translating and qualifying impulses to the cerebral cortex. It may be important to note that there are two subordinate systems working in the RAS. The diffuse projection system seems to take account mainly of the urgency of stimuli and to ignore their finely discriminable properties. The specific projection system preserves

information about the exact location and quality of the stimulus all the way from receptor to cortical projection area (Berlyne, 1960). When the reticular formation is excited, an activation pattern also known as the arousal pattern or desynchronization results. Some characteristics of this pattern are desynchronization of the EEG alpha rhythm and orienting behavior characteristic of an attention state.

One major view concerning arousal level as a motivator of behavior (Duffy, 1957; Berlyne, 1960) asserts that the organism seeks to maintain an optimal level of arousal and will respond to changes in the environment in such a way as to restore the level of arousal to its optimum. Malmo (1957) saw the need for expanding the dimension of arousal so as to include the psychological condition of higher animals or human beings. He reported that patients suffering from chronic anxiety states tended to have flat and relatively alpha-free EEG patterns and showed greater irregularity in breathing, heart rate, neck-muscle activity, and finger-muscle activity than normal persons when they were subjected to stressful situations. Loomis, Harvey, and Hobart (1936) reported that alpha waves commonly disappeared from EEG tracings when subjects were exposed to fear-inducing conditions, e.g., when they imagined themselves in some terrifying predicament. There is some evidence to suggest that pleasant emotional excitement and rewarding stimuli also heighten arousal. Yoshii and Tsukiyama (1952) found that the EEG waves of the rat take on a higher frequency when the rat, placed in a maze, approaches a goal box containing food. Although many external stimuli have been tested for arousal capacity, visual stimuli have by far been the most researched. Several studies have obtained effective ratings of visual stimuli along such dimensions as interestingness, pleasingness, and preference (Berlyne, 1963; Day, 1967; Eisenman, 1966, 1967; Eisenman & Rappaport, 1967; Osborne & Farley, 1970). These studies have been instrumental in pointing out that certain types of people, e.g., first-born females vs. later-born females, respond more readily to particular kinds and degrees of stimuli than others.

One of the most prevalent problems listed in the experimental literature on verbal learning concerns the effect of motivation on acquisition and retention. The vast majority of experimental investigations of verbal learning before the 1960's manipulated the classical associative factors such as degree of learning, frequency of stimulus presentation, meaningfulness of items, and similarity of material (Weiner, 1966). Weiner (1966) suggests that the non-associative factors which include motivation should not be limited to the concept of drive but should include the temporary arousal states or activation levels (Duffy, 1962) of the individual. Studies by Obrist (1950) and Thompson and Obrist (1964) measured GSR and EEG changes during the serial learning of nonsense syllables. It was shown that while Ss were engaged in learning, mean GSR was higher during learning than during control [non-learning] periods and both GSR and EEG revealed a tendency for each stimulus cue to produce the highest degree of arousal at about the time it was first correctly anticipated. Obrist (1962) found that correct anticipations on different days were linearly related to heart-rate and electrodermographic measures of autonomic activity in two subjects, and curvilinearly related in three subjects. Berry (1962) measured skin conductance on Ss while they were learning PA items and found that the greatest amount of recall was associated with intermediate conductance levels.

Walker and Tarte (1963) developed a theory of learning and retention which incorporated the concepts of perseverative consolidation, action decrement, and arousal. The basic contentions of this theory are as follows:

> (1) The occurrence of any psychological event, such as an effort to learn an item of a paired-associate list, sets up an active, perseverative trace process which persists for a considerable period of time. (2) The perseverative process has two important dynamic characteristics: (a) permanent memory is laid down during this active phase in a gradual fashion; (b) during the active period, there is a degree of temporary inhibition of recall, i.e., action decrement (this negative bias against repetition serves to protect the consolidating trace against disruption). (3) High arousal during the associative process will result in a more intensely active trace process. The more intense activity will result in greater ultimate memory but greater temporary inhibition against recall.

Several studies have tended to support the Walker and Tarte hypotheses. In a PA task, Kleinsmith and Kaplan (1963) varied the level of arousal of eight single words used as stimuli and the time interval used to measure recall. The results indicated that learning under low arousal as defined by little change in skin resistance showed greater immediate recall compared to delayed recall (45 minutes

and 1week), whereas items learned under high arousal as indicated by a large skin resistance change demonstrated poor immediate recall but high recall on tests 45 minutes and 1 week later.

Walker and Tarte (1963) replicated the Kleinsmith and Kaplan study using homogeneous and mixed lists of high- and low-arousal words as stimulus terms and single digits as response terms. Measures of skin resistance were taken during learning. Nine groups of subjects representing the three list conditions (high arousal, low arousal, and mixed) were tested for recall at time intervals of either 2 minutes, 45 minutes, or 1 week after training. Low arousal words were recalled best during the 2-minute time interval and decreased as a function of time. High arousal words were recalled slightly better during the one-week time interval but dropped lowest at the 45-minute time interval. Consequently, the results exhibited the same trends as those obtained by Kleinsmith and Kaplan (1963b, 1964), but were not of the same magnitude.

Kaplan, Kaplan, and Sampson (1968) used verbal and visual materials to further test arousal formulations. Forty male Ss were presented 24 items, half as words and half as simple line drawings with the instruction to try to remember them. Picture recall was significantly greater than word recall ($p < .001$). It was suggested that the GSR findings point to a verbal encoding both for words and pictures. The most important finding, however, was that items which showed poor immediate recall and good long-term recall were associated with a larger arousal reaction than an item that was recalled only initially.

The general findings of studies employing arousal-producing stimulus terms, delayed auditory feedback, ego-involvement procedures, drugs, and white noise suggest that arousal facilitates long-term retention. The relationship of arousal and immediate recall has been more difficult to determine. Arousal was also found to have a detrimental effect on immediate recall in the studies by Berlyne, et al., (1965), King and Dodge (1965), King and Wolf (1965), Levonian (1966), Kaplan, Kaplan, and Sampson (1968), Farley and Gilbert (1968), Lovejoy and Farley (1969), Manske and Farley (1970), and Osborne and Farley (1971). On the other hand, no detrimental effect was found by Berlyne (1966), Alper (1948), Farley (1969), Haveman and Farley (1969), and Maltzman, Kantor, and Langdon (1966).

In an attempt to extend the arousal and memory research to the role of interest in learning, a series of studies has been conducted utilizing paired-associate and free recall paradigms (Jones & Farley, 1970; Krueger & Farley, 1970) and learning materials varying in interestingness, with these variations in level of interest serving as the sources of arousal. Kreuger and Farley employed a multitrial free recall paradigm utilizing 18 words at three levels of rated interest. High interest words were found to be better recalled than middle or low interest words, with the latter two being undifferentiated. In the Jones and Farley report, a PA paradigm was used, with random polygons as stimulus terms and words as response terms. Interestingness was varied at three levels on both the stimulus and response side. This study was specifically a retention study, with immediate and long-term retention conditions, and controls for degree of original learning using Underwood's (1964) recommendations. The retention results were exceedingly complex, with an 18 group design, but indicated that interest had a significant main effect on the response side, with middle levels of response interestingness leading to best retention, and with a significant interaction between the stimulus and response terms with retention interval collapsed. One of the problems in the Jones and Farley (1970) study was the use of pictorial materials as stimuli and words as responses. In addition, some question of list differentiation on variables other than interestingness was raised, e.g., the lists were not as well matched on such important attributes as imagery and concreteness-abstractness as one might like. As mentioned above, the Jones and Farley study was a retention experiment, without a detailed analysis of initial acquisition.

The variables of word abstractness, imagery, and meaningfulness have been studied intensively to determine their influence on learning. Paivio (1965) found that whether the stimulus and response terms were high or low in imagery and abstractness determined their effectiveness in a PA task. The predicted learning difficulty of four stimulus-response combinations was as follows: concrete-concrete, concrete-abstract, abstract-concrete, and abstract-abstract, in increasing order of difficulty. Analysis of recall scores strongly supported that prediction. It was also predicted, on the basis of a conceptual-peg theory, that concrete stimulus nouns would elicit mediators more readily than abstract stimulus nouns and therefore would be more effective as cues for associated response items. That position was also supported by the data, with the facilitating role of imagery being located primarily in the stimulus term.

Paivio and Yuille (1966) with children as Ss also found concreteness to be most effective on the stimulus side even when the variable

of meaningfulness was held constant. Consistent with the findings for adults (e.g., Paivio, 1965), stimulus concreteness was generally a more potent variable than response concreteness. However, the superiority of concreteness on the stimulus side was less reliable in the case of children. Two possibilities were presented in attempting to account for this difference. One possibility was that adults made more effective use of stimulus-evoked imagery, perhaps because of more experience with mnemonic aids. The second possibility was that the advantage gained by concrete stimuli in C-A as compared to A-C pairs was evidently reduced by low meaningfulness of the abstract responses, more among the younger Ss for whom response learning was a relatively greater problem. Paivio (1967) well recognized the possibility that other factors may be strongly influencing verbal performance. The specific manner in which nonverbal and non-familiar objects are coded has not been solved. The possibility of more than one coding system has not been fully explored. Paivio interpreted free recall data in terms of two coding systems. He stated that objects or their pictures could be stored relatively directly as concrete memory images if they are familiar and unambiguous. Memory storage, therefore, could be in either or both symbolic modes, and either mode could readily mediate the appropriate response during verbal recall. However, if the subject is unfamiliar or ambiguous, the label would not be readily available and difficulty would be encountered when the task required a labeling response. Paivio suggested that concrete nouns could be stored directly as words and they might evoke nonverbal images of the referents of the words as well. Finally, he suggested that abstract nouns would likely be represented only in their verbal form. Thus, the availability of the two coding systems of modes of representation would vary directly with the concreteness of the stimuli. Individual differences in relevant symbolic habits, such as imagery ability and verbal associative fluency, must be considered before the preceding hypothesis can be tested.

The present research extended the study of interest by Jones and Farley (1970). The Jones-Farley study was improved upon by using words both as stimulus and response terms rather than pictorial stimuli and verbal responses. The variables of meaningfulness, imagery, and concreteness were also held constant in the present study. The basic question of this study was to find out whether or not various levels of interest (arousal) do in fact influence learning.

II
METHOD

DESIGN

A 3 x 3 fixed effects factorial design was used employing all possible combinations of three levels of PA stimulus term "interestingness" (high, medium, and low), and three levels of response term "interestingness" (high, medium, and low).

MATERIALS

The first part of the study involved word ratings, using previously obtained local ratings of 90 Ss (Farley, Jones, & Manske, 1967) and comparable ratings gathered for the present study on 90 Ss, that consisted in total of 187 words rated on 1-7 point scales of interestingness (I), imagery (Im), and concreteness (Conc). In addition, Noble's (1952) production m (using 30 sec. production periods) was obtained on the words except for a number of them for which m data were available from Paivio, Yuille, and Madigan (1967). Frequency values for each word were obtained from the Thorndike-Lorge word count (Thorndike & Lorge, 1944). Where the local ratings were concerned, the order of the rating forms was randomized such that no S rated the words in the same order so as to control for set in responding and for fatigue effects such as random responding toward the end. Thus, the pool of 187 words were scaled for interestingness, imagery, concreteness, meaningfulness (Noble's m), and Thorndike-Lorge counts. Based on the mean interest of each word and equated on Im., Conc., m., and word freq., groups of eighteen words each were selected from the extremes and middle of the interestingness dimension to represent high, middle, and low S-R interest levels. Group means for the interestingness ratings were high-2.10, medium-3.71, and low-4.76.

PROCEDURE

In the learning task, items were presented in booklets, made up on the first trial of S-R pairs on each page, with subsequent trials consisting of one stimulus term on a given page followed on the next page by the S-R pair. Assignment of response to stimulus terms was random for Ss under each of the nine treatment conditions with the provision, however, that obvious associates were repaired. The order of items was varied randomly for each trial to control for serial order effects.

The time intervals consisted of 4 seconds for learning the stimulus-response pair and 4 seconds for responding to the stimulus term. The anticipation method was used for learning.

SUBJECTS

Ninety University of Wisconsin students in introductory educational psychology classes with some on a voluntary basis and some for experimental points were used as subjects. There were 27 males who listed their ages (mean age = 25.77, S. D. = 6.02) and 57 females who listed their ages (mean age = 23.92, S. D. = 5.84) used in the study. When sexes were combined the mean age was 24.52 and the S. D. was 5.89. [Six subjects neglected to list their age.] Subjects were randomly assigned to the nine treatment tasks with 10 Ss per group. During Trial One, stimuli and responses were presented together for 4 seconds with the stimulus word to the left and the response word to the right. The second training trial consisted of presenting the stimulus term alone for 4 seconds on the left of the booklet page. A blank space was provided to the right of the stimulus term where the subject was to write in the correct

response. At the end of the 4 seconds, the stimulus term was presented again on the next page for 4 seconds while paired with the correct response printed to the right. Thus the standard P-A anticipation procedure was used with a 4-second presentation rate, and this procedure closely approximated that of Jones and Farley (1970). No inter-trial interval was employed other than that required to turn a page in the booklet. Ten trials were administered with two successive correct trials being used as a trials-to-criterion measure. Each subject was given the following directions:

> You will receive four booklets numbered 1 through 4. Do not open the booklets. Fill in the information asked for on the first booklet.
>
> This is a learning experiment in which you will learn to associate words. It is very important that you follow the instructions to the best of your ability. Should you fail to follow any instruction, tell me at the end of the experiment, since the interpretation of the results may be affected.
>
> When the E says "turn", turn one page at a time in the first booklet. At first two words will appear on each page. Eventually only one word will appear on the left of the page. Each time this happens, you are to write down the word which was previously paired with it. It is important that you turn each page when the experimenter says "turn." Even if you did not have time to finish writing a word, do not turn back to any page. Be sure to turn only one page at a time.
>
> When you finish with the booklet numbered 1, go on to the next booklet numbered 2 and so forth. Always try to get as many of the pairs correct as you can. You should try to perform as best you can on each trial, even though you may have all of the words correct on some of the preceding trials.

ANALYSIS OF DATA

In order to answer the previously stated questions, two analyses of variance with certain planned comparisons were carried out. In order to determine the effect of treatment on learning, a 3 x 3 analysis of variance, with three levels (high, middle, and low interest) at each of two factors (stimulus versus response side in the PA task), was carried out utilizing the trials to criterion measure. In order to determine more discriminately the interaction between subjects, trials, and treatment, a 3 x 3 x 10 analysis of variance was also performed utilizing S's performance over all 10 trials. The three basic treatment conditions (high-medium-low) on the response side were also collapsed to see if they were significantly different, utilzing a planned comparison of the middle versus the two extremes, and also between each of the extremes, on the basis of the Jones and Farley (1970) results.

III
RESULTS

The main results for the nine treatment conditions in terms of mean trials to criterion are listed in Table 1. The results show that the treatment conditions most easily learned were the high-medium (Mean = 5.1), the medium-medium condition (Mean = 5.6) and the low-medium condition (Mean = 5.7). Although these three conditions did not differ significantly from the other six conditions, it is interesting to note that the three lowest trials to criterion included in each case the medium response condition. An analysis of variance of the results yielded an F-ratio for the interaction of 0.373 with 4 df, which was not significant. These results can be seen in Table 2, where the lack of significance for the stimulus effect is also apparent. The planned comparison between high, medium, and low response conditions yielded no significance. Using the following symbols: R_H = high response group, R_M = medium response group, and R_L = low response group, the analysis suggested that the largest pairwise comparison among response groups was between R_M and R_L with 1 and 81 df; F = 3.192 (n.s.). The comparison between (R_H + R_L) and R_M resulted in an F = 3.259 with 1 and 81 df (n.s.). The final comparison between R_L and R_H yielded an F = 0.200 with 1 and 81 df (n.s.). In Figure 1 is presented graphically the mean collapsed response effects, illustrating the trend toward superior acquisition for middle levels of response interest relative to high and low response interest.

A graphic representation of performance across all trials in the nine treatment conditions is presented in Figure 2. These data were analyzed in a 3 x 3 x 10 analysis of

Table 1

Mean Trials to Criterion for the Nine Conditions

	Treatment Condition	Mean	SD
H-H	(High interest stimulus - high interest response)	6.4000	2.5473
H-M	(High interest stimulus - medium interest response)	5.1000	3.6347
H-L	(High interest stimulus - low interest response)	6.4000	3.0258
M-H	(Medium interest stimulus - high interest response)	7.2000	3.3928
M-M	(Medium interest stimulus - medium interest response)	5.6000	3.2041
M-L	(Medium interest stimulus - low interest response)	5.8000	3.7357
L-H	(Low interest stimulus - high interest response)	6.5000	4.0069
L-M	(Low interest stimulus - medium interest response)	5.7000	2.5841
L-L	(Low interest stimulus - low interest response)	7.7000	2.6687

Table 2

Analysis of Variance of Trials to Criterion
for the Nine Conditions

Source	SS	df	MS	F	P
Mean	3534.400	1	3534.400	--	--
Stimulus	6.864	2	3.432	0.285	n.s.
Response	28.862	2	14.431	1.200	n.s.
Stimulus x Response	17.957	4	4.489	0.373	n.s.
Error-Within Cell	974.187	81	12.027	--	--

variance with the three levels of the first factor representing high, middle, and low stimulus interest, the three levels of the second factor representing high, middle, and low response interest, and the 10 levels of the third (repeated measures) factor representing the 10 trials. The results of this analysis are found in Table 3.

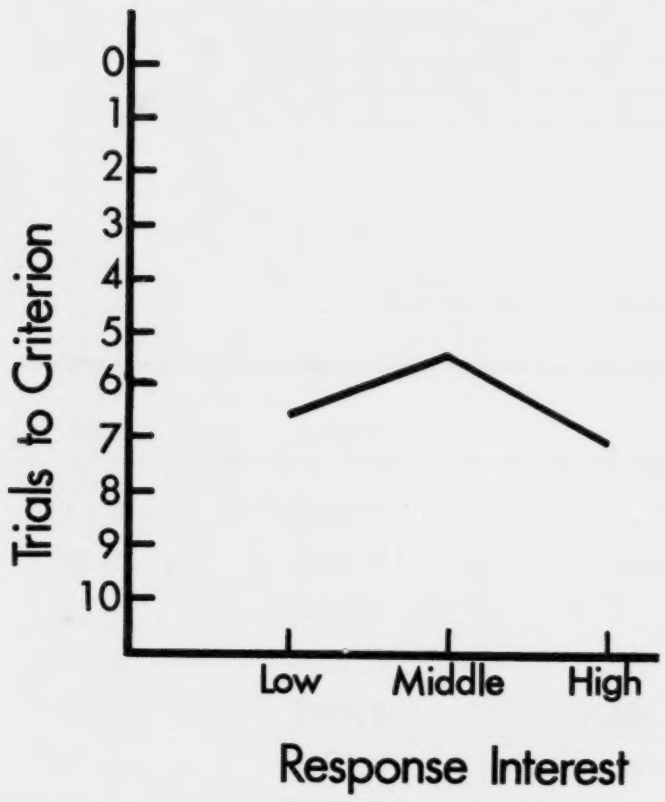

Fig. 1. Mean Trials to Criterion Scores for the Low, Middle, and High Response Conditions

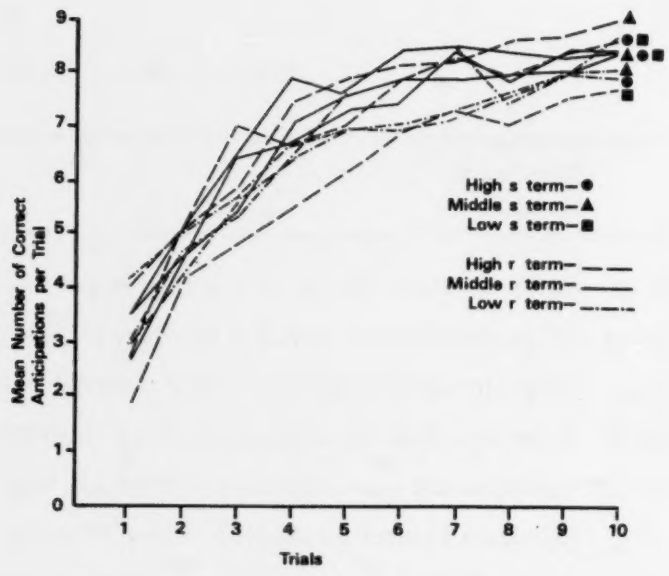

Fig. 2. Acquisition Curves for the Nine Treatment Conditions

Table 3

Analysis of Variance of Performance Over Ten Trials
for the Nine Conditions

Source	MS	df	F-ratio	P
Between Subjects (total)		90	--	--
Mean		1		
Stimulus Differences	10.36	2	0.358	.70
Response Differences (total)	18.76	2	0.648	.75
H vs. L *	8.64	1	0.299	.59
M vs. H + L/M *	28.88	1	0.998	.32
Stimulus x Response	25.15	4	0.869	.49
Between Subjects Within Groups	28.94	81	--	--
Within Subjects by Trial		810		
Trial	259.67	9	179.100	.0001
Stimulus x Trial	1.19	18	0.820	.75
Response x Trial (total)	1.66	18	1.140	.50
L vs. H x Trial	1.52	9	1.050	.50
M vs. (H + L) / M x Trial	1.80	9	1.240	.50
Stimulus x Response x Trial	1.00	36	0.690	.50
Subjects x Trials Within Groups	1.4499	729	--	--

* H = High Interest; M = Medium Interest; L = Low Interest

IV
DISCUSSION

The various arousal levels represented by high, medium, and low interest stimulus and response words produced no significant difference between the nine treatment groups. The only significant effect was the trials main effect, but in such a learning task, this was to be expected. Level of interest on the response side, however, provided some interesting if not significant results.

One of the objectives of the present study was to improve on the methodology of previous studies by controlling for such intervening variables as meaningfulness, imagery, and concreteness. This study accomplished the previously stated objective, while yielding results which, in one way, approached the results of previous researchers.

In the previous study (Jones & Farley, 1970), the results revealed significantly greater retention of the medium-interest response word group. The results of the present experiment showed that the collapsed response condition was learned in the least number of trials of any group.

These results point to the possibility of an inverted U phenomenon relating recall to arousal. Berry (1962), in an experiment which attempted to relate skin resistance to recall scores, found that moderate levels of skin conductance in the first minute of the learning session contributed to better recall. Kleinsmith and Kaplan (1963, 1964) argued that arousal was a critical variable in the patterning of verbal recall over time. Their results revealed that learning under conditions of low arousal resulted in the traditional forgetting pattern: short-term or immediate recall was superior but long-term recall decreased substantially with time. On the other hand, they found that high arousal learning exhibited a strong reminiscence pattern: poor immediate recall, but strong permanent recall.

In order to substantiate Berry's (1962) assertion that an inverted U shaped relationship of arousal to learning existed, Kleinsmith, Kaplan, and Tarte (1963) replicated Berry's experimental design, and in addition, added a 1-week recall group (long-term memory group). The purpose of the additional procedure (LTM), in essence, was to test the inverted U hypothesis in terms of long-term memory. The results of the study revealed that in the short-term condition an inverted U relationship was obtained, while the 1-week recall test indicated a positive linear relationship between arousal and retention.

In essence, the present results followed the same trend as the Berry (1962) and the Kleinsmith, Kaplan, and Tarte (1963) (short-term 6 min. recall) studies. Although individual differences in Ss were not controlled for in the present study, the results reflect the possibility that optimal learning of a short-term nature takes place during moderate arousal conditions on the response side in a PA task.

The study of human learning from the standpoint of arousal properties and eliciting capacity of materials has great potential in the area of education as well as in the basic concerns of learning theory and research. Classroom teachers, laymen, and learning theorists have long suspected that the variable of interest plays an important role in the learning process. The current equivalent of interest may be reflected in the demand for relevance in learning institutions. However, the problem of presenting interesting materials as well as materials which facilitate learning remains difficult. Hence, the possibility that interest can be shown to influence systematically the short- and long-term retention of verbal materials is of dire importance to the improvement of education.

Current research suggests that arousal does play an important role in learning and memory. However, discrepancies concerning specific predictable characteristics of various levels of arousal on learning and memory must be researched further in order to define more clearly the laws involved.

Designs for further research should continue to control for such factors as meaningfulness, imagery, and concreteness in order to maximize valid decisions concerning interest. Future studies should increase cell size, and if possible, include a long-term retention interval. The present data were analyzed using the traditional analyses of variance. However, there is a possibility that certain assumptions were violated. Every cell has a probability of being a cell with no errors. Do the probabilities differ from cell to cell? Since the distribution in the present study was not necessarily a normal one, the negative binomial might be the best method of analysis in the future, since it assumes that distributions are not necessarily normal.

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